

**CONFINED SPACE
IDENTIFICATION AND HAZARD DOCUMENTATION**

EXECUTIVE DEVELOPMENT

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ABSTRACT

This research project analyzed the information needed to assist a company officer in identifying confined spaces, their probable locations within a community, and the types of hazards associated with them. The problem was that confined spaces pose a significant threat to citizens and firefighters. There was no method for gathering information and a lack of understanding of the potential hazards.

The purpose of the project was to develop a confined space identification worksheet that could be used by a company officer in conjunction with an inspection program. This worksheet would assist them in identifying and documenting the hazards of confined spaces.

The research methods that were used were both action and historical. The research focused on addressing the following areas: (a) definitions of confined spaces and permit required confined spaces, (b) types of business occupancies that are prone to have confined spaces, (c) information helpful in identifying confined spaces, and (d) documenting confined spaces and their hazards.

The procedure used for this project was a review of the applicable state and federal statutes, case studies of incidents, fatality and cause statistics, and other informational materials on confined spaces.

The results of the research indicated that confined spaces pose a serious hazard. They can be in any occupancy and in many different configurations. Their hazards are diverse

and can be constantly in transition. The findings in the research were applied to the production of a confined space identification worksheet for field use.

The recommendations resulting from this research include: (a) train personnel in utilizing the worksheet, (b) utilize the worksheet to identify confined spaces in conjunction with a company inspection program, and (c) develop a follow-up program to work with occupancies that have confined spaces to assist in mitigating and understanding the hazards.

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INTRODUCTION

The Spokane Valley Fire Department (SVFD) encompasses 77 square miles and protects 110,000 citizens. Within this area are both light and heavy industries as well as over 3,900 business occupancies. Many of these occupancies have confined spaces and neither the business owners or the SVFD are aware of them. The problem is that these confined spaces pose a significant hazard to both citizens and firefighters, and needed to be identified and have their hazards documented.

The purpose of this research project was to develop a confined space identification worksheet that would assist a company officer in identifying the spaces and documenting the hazards during a company building inspection. Action research supported by historical research were the methods used to answer the following questions:

1. What constitutes a confined space and a permit required confined space?
2. What type of business occupancies are the most likely to have confined spaces?
3. What information is needed to assist the company officer in identifying confined spaces?
4. What information will need to be obtained by the company officer to document the confined spaces' associated hazards?

BACKGROUND AND SIGNIFICANCE

The hazards of confined spaces have been told throughout

history. Pettit, Braddee, Suruda, Castillo, and Helmkamp (1996) wrote that the Roman Emperor Trajan was said to have sentenced criminals to clean sewers because of the hazards. In 1556, Agricola noted that breathing difficulties in mines was caused by stagnant air and that fires in mines caused swift death to those who remained inside. Alice Hamilton, in 1925, observed that deaths from asphyxiation were being caused by hydrogen sulfide being produced by decomposing organic matter in vats, manholes, and tanks (Pettit et al, 1996).

To address the injuries and fatalities that were occurring in confined spaces the Occupational Safety and Health Administration (OSHA), in July of 1979, issued an advanced notice of rulemaking for confined spaces. Over thirteen years later, on January 14th, 1993, the final rule was adopted; 29 Certified Federal Register (CFR) parts 1910.146, permit required confined spaces (Mansdorf, 1995).

Washington State is an OSHA plan state which requires Washington State to meet or exceed the OSHA standards. In Washington, employers must abide by the Washington Administrative Code (WAC) 296-62-145, Part M Confined Spaces. It contains the minimum requirements for practices and procedures to protect employees in all industries from the hazards of entry and/or work in permit required confined spaces (PRCS)(Washington Administrative Code [WAC], 1995). The significance of this law is that employers, including the SVFD, are required to evaluate the workplace to determine if any confined spaces are PRCS. They are further required to

identify and evaluate the hazards of the spaces before employees enter them.

Minter (1994) found estimates by OSHA that there are 240,000 employers in general industry that have workplaces where 4.8 million confined spaces exist. If the employer finds PRCS they must establish a written program for safe entry and provide for hazard identification, monitoring, employee training, and rescue capability.

The SVFD employs one hundred and twenty nine fully paid professional firefighters. Its facilities include seven stations and a training and maintenance facility. Currently it provides a minimum of 28 firefighter personnel on duty every day with 10 responding apparatus. The primary services provided are fire suppression, emergency medical services including basic life support and advanced life support, technical rescue, inspections, arson investigation, and fire prevention. Annually the SVFD responds to approximately 7,400 calls for help in a mostly urban and expanding area.

Every year the SVFD inspects every business occupancy within its jurisdiction. This program is accomplished with personal visits by one of the thirty company officers or one of the three inspectors in its Prevention Division. It has over 3,900 businesses within its jurisdiction. These businesses include hospitals, repair garages, fabrication facilities, tank farms, water districts, boat manufactures, electronics plants, some heavy industries, and many others. Many of these occupancies have confined spaces. The majority

of these confined spaces are not currently identified nor have their hazards been evaluated.

As an organization, the SVFD has defined its role within the community through its mission statement, "The Spokane Valley Fire Department is an all-risk emergency agency, protecting its citizen's lives, property, and the environment through a cost effective and responsive people oriented service" (Spokane Valley Fire Department, 1994). The SVFD administration has further defined that mission to include the provision of technical rescue services in the area of confined spaces. The identification of our community's confined spaces and their associated hazards is essential to fulfilling this mission as well as providing safety to our citizens and firefighters.

Serving the needs of our citizens is the objective of the SVFD. One of those needs is assisting them in understanding the hazards and regulations associated with confined spaces. This type of assistance was one of the topics discussed in both the Service Quality Module and Legal Issues Module of the Executive Development class at the National Fire Academy in the spring of 1998.

LITERATURE REVIEW

The literature review for this research project was focused into three main categories. The first was to review the definitions of what constitutes a confined space and a PRCS. The second review was to determine what type of business

occupancies and/or locations are most likely to have confined spaces. The third area of review was to identify the types of hazards associated with confined spaces in order that they may be evaluated and documented.

Confined Spaces, Permit Required Confined Spaces - Defined

The definitions of confined spaces and PRCs in the literature review all came from the same source, the OSHA standard, 29 CFR 1910.146. The WAC standard, 296-62-145 Part M, and the OSHA standard are exactly the same. Because these are Federal and State regulations there was no latitude for modifying the legal definitions by the various authors.

Federal and State regulations use the following definition:

Confined space means a space that:

(1) Is large enough and so configured that an employee can bodily enter and perform assigned work; and

(2) Has limited or restricted means for entry or exit (For example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.); and

(3) Is not designed for continuous employee occupancy.

(OSHA, 1993, p. B-2) and (WAC, 1995, p. 2)

Once a space has been identified, and by definition it was found to be a confined space, the next step was to identify if there were any associated hazards. If there were hazards that fall within the definition of a PRC then a written program must be established in order to enter that space.

The regulations further define a PRCS as:

Permit-required confined spaces (permit space) means a confined space that has one or more of the following characteristics:

(1) Contains or has a potential to contain a hazardous atmosphere;

(2) Contains a material that has a potential for engulfing an entrant;

(3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a small cross section; or

(4) Contains any other recognized serious safety or health hazard. (OSHA, 1993, p. B-2) and (WAC, 1995, p. 4)

Rekus (1997) gives a good description of confined spaces that are non-permit as those that don't present hazards that could cause death or serious injury. Some examples he mentioned were dropped ceilings, telephone equipment closets, mechanical cabinets, and some building crawl spaces. He further cites how OSHA defines serious, as in section 4 of the definition of PRCS. Serious is defined as, "substantial probability that death or serious physical harm could result from a condition which exists, or from one or more practices, means, methods, operations, or processes which have been adopted or are in use". (p. 30)

It was clear in the review that understanding what defines confined spaces and PRCS is the foundation for their

identification and categorization.

Business occupancies and locations of confined spaces

Every business, both large and small, that you come in contact with has the potential to have confined spaces. The spaces can be anywhere and in almost any configuration. They can be permanent structures like gas storage tanks, pits, industrial ventilation systems, commercial ovens, vaults, storm drains, drafting pits, sprinkler vaults, dumpsters, and grain silos. They can be mobile; railroad tank cars, cement trucks, gravel trucks, pipe haulers, garbage trucks, and lawn spray vehicles (Britt, 1994; Mansdorf, 1995; Minter, 1994; Pettit, et al., 1996).

Some of the most common occupancies were identified by Suruda, Pettit, Noonan, and Rouk (1994) in their reporting of statistics on confined space fatalities by industry from the National Traumatic Occupational Fatalities (NTOF) surveillance system as shown in Appendix B. By reviewing the data from the NTOF it was clear that most communities have business occupancies and locations that will have confined spaces.

Hazards associated with confined spaces

Some of the hazards found in confined spaces are complicated by the number and access to the entry points. A good size-up of the area and any other associated hazards is needed to gain a global view of potential hazards. Some hazards have to be assumed. Collins (1997) reminds us that every confined space should be considered immediately dangerous to life and health (IDLH) until you are able to

prove it otherwise.

In a description of an incident some twenty years ago, Derocher (1997) explained how three workers died in a long wide pipe that went between two drainage ponds. Hydrogen sulfide, a colorless and tasteless gas, was produced by decaying organic matter and settled into the low areas replacing the oxygen. Two of the fatalities were rescuers. Conditions can change in confined spaces over time. At one point there was no hazard and the workers were safe! Later, be it from whatever source, a deadly condition had been created.

Sometimes the employees will create the hazards themselves. In 1980 four workers that were cleaning out a tank decided to introduce some fresh air on a hot day. What was in the tank initially was not a serious hazard but what they put into the tank was Nitrogen and it became a hazard. The first entrant collapsed and the next three tried to rescue him and also collapsed, one at a time (Britt, 1994).

One worker returned to a pit to retrieve a tool at a sewage pumping station that was under construction and collapsed. Five rescuers, three of them police officers, entered the pit and were overcome by the atmosphere. One of the police officers died as a result. The atmosphere had been replaced with methane and hydrogen sulfide (Roughton, 1993).

The hazards contained within confined spaces are designated by definition to be hazardous atmospheres, engulfment, entrapment, asphyxiation by some structure, or any other serious hazard. The most deadly and prevalent hazards

indicated by the review were those posed by IDLH atmospheres.

The NTOF surveillance system as reported by Suruda et al. (1994) shows that over a 9 year period (1980 - 1988) there were 803 reported deaths in confined spaces. Of those 62% were caused by IDLH atmospheric hazards, 28% caused by mechanical suffocation by one means or another, and 10% from other causes of injury.

Further NTOF data shown by Pettit et al. (1996) shows that hydrogen sulfide, methane, inert gases, sewer gases, carbon monoxide, and oxygen deficiency were the most identified atmospheric causes of death on the death certificates. Some excellent examples of toxic gases that can be found in confined spaces are given by Suruda et al. (1994) and are listed in Appendix A.

The consumption of oxygen within a confined space can also pose a serious health hazard. Oxygen is consumed in many ways, both by the processes or work being performed or by the employees doing the work. Without sufficient ventilation the number of workers can have a serious effect on the oxygen level. Oklahoma State University (1995), in their manual on working in confined spaces, refers to the fermentation process, cutting, welding, combustion of flammable materials, and the formation of rust as processes that all consume oxygen.

As for the 28% of deaths reported because of mechanical suffocation, asphyxiation, and engulfment; the data reported by Pettit et al. (1996) shows that grain caused five times as

many deaths as did other agricultural products or loose materials such as sand, gravel, cement, clay, or sawdust.

The review did not produce substantial information on the remaining deaths except that the typical confined space is hazardous because of its shape and location. Many confined spaces are in lower areas and that position produces the potential for many of the atmospheric hazards. Foster (1994) also discusses the need for fall prevention and protection from objects falling. These hazards contribute to the difficulty in gaining access and egress from the space.

PROCEDURES

Definition of Terms

Immediately dangerous to life and health (IDLH). "Any condition that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects or that would interfere with an individual's ability to escape unaided from a permit space" (WAC, 1995, p. 3).

Material Safety Data Sheet (MSDS). "A form, provided by manufactures and compounders (blenders) of chemicals, containing information about chemical composition, physical and chemical properties, health and safety hazards, emergency response, and waste disposal of the material as required by 29 CFR 1910.1200" (National Fire Protection Association, Hazardous Materials Response Handbook, 1993, p. 125).

Research Methodology

The desired outcome of this research was to create a

confined space identification worksheet that would assist a company officer in identifying confined spaces and PRCS as well as document the spaces' associated hazards. The research was historical in that a literature review was conducted to examine the statutory definitions of what constitutes confined spaces and PRCS, identify the type of business occupancies that are likely to have these spaces, and identify the types of hazards that may be encountered.

The research was action in that the information gathered in the historical research was used to produce a confined space identification worksheet that can be used within a company inspection program or on its own. This worksheet appears in Appendix C.

Limitations

The confined space identification worksheet does not illustrate all of the business occupancies or locations where confined spaces may be encountered, nor does the worksheet identify all of the potential hazards that may be found. A genuine interest in finding confined spaces will need to be displayed by the user and an interest in understanding the hazards involved for the worksheet to be effective.

Further the OSHA requirements within, 29 CFR 1910.146, being a general industry standard, do not apply to the confined spaces in construction, ship building, or agriculture as explained by Britt (1994), even though the hazards undoubtedly still exist. Suruda et al. (1994) also explains that the OSHA standard will not apply to workplaces

with fewer than 11 employees, self employed persons, and state, federal, and municipal employees of states, under federal rather than state OSHA plans.

RESULTS

Answer to Research Questions

Research Question 1: What constitutes a confined space and a permit required confined space?

According to Federal and State regulations,

"Confined space means a space that:

(1) Is large enough and so configured that an employee can bodily enter and perform assigned work; and

(2) Has limited or restricted means for entry or exit (For example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.) and

(3) Is not designed for continuous employee occupancy."

(OSHA, 1993, p. B-2) and (WAC, 1995, p. 2)

They further define:

"Permit-required confined space (permit space) means a confined space that has one or more of the following characteristics:

(1) Contains or has a potential to contain a hazardous atmosphere;

(2) Contains a material that has a potential for engulfing an entrant;

(3) Has an internal configuration such that an entrant

could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a small cross section; or

(4) Contains any other recognized serious safety or health hazard." (OSHA, 1993, p. B-2) and (WAC, 1995, p. 4)

Research Question 2: What type of business occupancies are the most likely to have confined spaces?

Confined spaces are found in all types of business occupancies regardless of size or location. In Appendix B, the NTOF study discussed by Suruda et al. (1994) shows the industries of employment where reportable fatalities have occurred, with a preponderance of them being in the manufacturing, agriculture, forestry, fishing, construction, transportation, and communication trades. Pettit et al. (1996) found that 76% of fatalities in confined spaces were in occupancies that did work in or on tanks, vats, pits, digesters, and sewer manholes.

Research Question 3: What information is needed to assist the company officer in identifying confined spaces?

A company officer needs to have a good understanding of the definition of a confined space as defined in WAC (1995) and OSHA (1993). Any information that the land owner, business owner or occupant may be able to provide about the sites and history of the spaces will also be needed.

Research Question 4: What information will need to be obtained by the company officer to document the confined

spaces' associated hazards?

The following information needs to be collected or the accessibility to it should be known and documented. The name, address, and phone number of the business occupancy should be recorded. A contact person that is knowledgeable in the operations of the business and of its spaces needs to be obtained. The access points to the space and any external hazards that may affect the space should be identified. The shape, size, name or description of the space need to be recorded. Any and all material safety data sheets (MSDS) of hazardous materials or chemicals that will be used in the space or that are used or stored on the site need to be documented (Collins, 1994). A description of the type of work that is done in the space and an understanding of how many and how often employees enter the space should be recorded. If this space has any incident history a synopsis of what took place needs to be documented. Identify who is the designated rescue agency if the space is permit required and obtain a copy of the occupancies PRCs program.

Produced Worksheet

A sample confined space identification worksheet is shown in Appendix C.

The worksheet is broken down into three parts. Part I is to assist the user in examining the occupancy for confined spaces by providing examples of known confined spaces.

Part II gives the definition for confined spaces so that any spaces that are found can be evaluated. If they meet the

definition then the necessary information that should be retrieved and documented is listed.

Part III is the definition of a PRCS and a list of common hazards. If the space meets this definition by having a serious safety or health hazard then more information is to be documented and the hazards listed.

DISCUSSION

The confined space worksheet, which represents the results of this research project, gives clear statutory definition of what a confined space and a PRCS are as listed in WAC (1995) and OSHA (1993). The hazards that these spaces can pose are significant and deadly for both citizens and firefighters alike. Sixty percent of the deaths, as reported by Foster (1994), are rescuers. The significance to the fire service and its rescue operations can be tremendous.

All communities have confined spaces. When you look at the data from the NTOF surveillance system that Suruda et al. (1994) showed us in Appendix B, you can see that most of our communities will have one or more of these industries. Pettit et al. (1996) further defines the most frequently encountered confined spaces, such as, tanks, pits, vats, and sewer manholes, that are in every community.

In the case studies by [Britt (1994), Derocher (1997) and Roughton (1993)], it is demonstrated that the hazards are deadly. It also shows the biggest contributor to these fatalities was the lack of understanding of the hazards that

can exist.

The SVFD serves a community with over 3,900 business occupancies and contains many of the manufacturing, agriculture, forestry, fishing, construction, transportation, and communication industries where confined spaces are the most likely to be found. With the use of the confined space identification worksheet in Appendix C, the SVFD will be able to identify these confined spaces and inform and educate ourselves and our citizens as to the hazards that they can present.

RECOMMENDATIONS

The SVFD should train its personnel in the ability to recognize confined spaces and their associated and varied hazards. The department should further train its personnel to utilize the Confined Space Worksheet that was produced and is in Appendix C.

The training that is given in the utilization of the worksheet should then be applied to the next season of company building inspections. Annually the department visits every business occupancy and with this training and a confined space worksheet, most of the spaces and their hazards will be identified and documented. Once identified, a follow-up program needs to be developed so that the business owners and the technical rescue team can work on ways to mitigate any hazards for the safety of the employees and possible rescuers.

An annual evaluation of the confined space worksheet

should be done to insure that the definitions remain relevant to the applicable laws and standards. It should also be reviewed to see if it can be improved after being in the field for one inspection season.

The SVFD needs to evaluate all of its fixed facilities and mobile equipment for the possibility of having confined spaces of its own. After that evaluation, if confined spaces are found and if any are defined as PRCS, a written PRCS program should be developed as prescribed by WAC 1995.

The hazards of confined spaces can be invisible and deadly to both the citizens that the department serves and the people that it employs. To fulfill its mission, the SVFD needs to address the confined space hazards within its community. The greatest tools it has to assist it in this task are information and education.

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Appendix A

**Examples of atmospheric hazards
in confined spaces.**

Appendix A**Examples of atmospheric hazards in confined spaces.**

Type	Example
Toxic gas monoxide,	Hydrogen sulfide, carbon hydrogen cyanide
Inert gas	Argon, helium, nitrogen
Simple asphyxiant	Nitrogen, methane, carbon dioxide
Oxygen deficiency displaced	Oxygen in air consumed or
Solvents	Freons, chlorinated hydrocarbons, gasoline
Explosive mixtures	Methane/air, toluene vapor/air

Appendix B

Industry of employment for
confined space victims who died
in work-related incidents during
1980-1988.

Appendix B

Industry of employment for confined space victims who died in work-related incidents during 1980-1988.

Industry division Total	Deaths in single victim incidents	Deaths in multiple victim incidents	
Manufacturing	141	51	192
Agriculture/forestry fishing	108	23	131
Construction	80	27	107
Transportation/ communication/public	58	42	100
Mining, including gas and oil	50	30	80
Not classified	54	17	71
Retail and wholesale trade	46	5	51
Services	33	13	46
Public administration	10	11	21
Total	584	219	803

Source: NTOF data 1980-1988

Appendix C

Confined Space Identification Worksheet

SPOKANE VALLEY FIRE DEPARTMENT

Confined Space Identification Worksheet

This worksheet provides assistance in determining if a space is either a confined space or a permit-required confined space (PRCS), and identifying and documenting its associated hazards.

PART I - Does this occupancy have any of this type of confined spaces or any that might be hazardous, see definition in Part II.

_____ Tanks	_____ Vats	_____ Pits
_____ Digesters	_____ Sewer Manholes	_____ Vaults
_____ Hoppers	_____ Boilers	_____ Dry Wells
_____ Silos	_____ Vessels	_____ Storage Bins

Space Identified -

PART II - Is the space a confined space? That means that:

1. _____ It is large enough and so configured that an employee _____ can bodily enter and perform assigned work; and
2. _____ It has limited or restricted means for entry or exit; _____ and
3. _____ It is not designed for continuous employee occupancy.

If you checked all of the items in Part II, you have a confined space and need to fill out the remainder of this form including the back, Part III! If not no further action is needed.

Date -

Business -

Address -

Phone Number -

Contact Person -

Evaluator -

How many employees enter this space, how often, to do what?

Has this space had any problems or a safety history?

Does the employer have MSDS sheets on any the chemicals used in this space?

**PART III - Permit Required Confined Space
and Hazard Identification**

If any of the items in Part III are checked, the confined space is a permit-required confined space. As such, entry into these spaces must be performed under the protection of a full permit-required confined space program as defined in WAC 296-62 Part M or 29 CFR Parts 1910.

1. Contains or has a potential to contain a hazardous atmosphere.
2. Contains a material that has the potential for engulfing an entrant.
3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section.
4. Contains any other recognized serious safety or health hazard.

Other recognized serious safety or health hazards to consider.

- | | |
|---|---|
| <input type="checkbox"/> Poor ventilation | <input type="checkbox"/> Low oxygen |
| <input type="checkbox"/> Enriched oxygen | <input type="checkbox"/> Energized Equipment |
| <input type="checkbox"/> Dry bulk products | <input type="checkbox"/> Radiation |
| <input type="checkbox"/> Moving parts | <input type="checkbox"/> Pressurized piping |
| <input type="checkbox"/> Toxic chemicals | <input type="checkbox"/> Unstable surfaces |
| <input type="checkbox"/> Sharp edges | <input type="checkbox"/> Hot surfaces |
| <input type="checkbox"/> Cold surfaces | <input type="checkbox"/> Corrosives |
| <input type="checkbox"/> Flammable products | <input type="checkbox"/> Fall hazards |
| <input type="checkbox"/> Rusting surfaces | <input type="checkbox"/> Oxygen consuming work |
| <input type="checkbox"/> Decomposing organic matter | <input type="checkbox"/> Poor visibility - 5 feet |
| <input type="checkbox"/> Biological contaminants | |

Does the employer have a written PRCs program?

Contact Person - _____ Phone Number - _____

Who is the designated rescue agency?

Send this completed form to the Division Chief of Training.